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Biological Agents and Their Effects on the Eye
Contributed by
Vision Center of Excellence

Despite existence of treaties prohibiting their use, biological weapons continue to pose a potential threat to national security.¹ As the effects of biological agents are often indiscriminant and can result in large numbers of casualties, their use, manufacture and storage have long been banned by many international committees.² Nevertheless, recent events have led to serious concerns that terrorist organizations and rogue states currently have access to these weapons. As recently as March of 2013, U.S. intelligence suggested that Syria, for example, had expanded their biological weapons program beyond research and development and will likely have the capacity to disperse these agents using rocket delivery systems.³

Infections caused by biological weapons can often be difficult to diagnose. Many health care providers are unfamiliar with the sequelae of this type of exposure, which may result in costly delays in diagnosis and treatment.⁴ Initial symptoms of exposure are generally non-specific and include high fever, headache, malaise, muscle aches, nausea and vomiting. As a result, it may take several days to identify a specific biological agent and lead to a worsening of the condition or even fatality. Additionally, the failure to take protective measures could result in further spread of infection as most biological warfare agents are designed to utilize a respiratory mode of transmission. While some infections from biological agents can be treated with antibiotics or vaccines (e.g., anthrax, tularemia), there are no effective treatments beyond supportive care for others such as infections caused by smallpox and botulism.

The eye is particularly vulnerable to bacterial and viral pathogens and may signal the first indication of contact. Pain, redness, irritation, inflammation, iritis, dry eyes and decreased visual acuity are all signs of potential exposure.⁵ Many agents also have dermatological sequelae in the form of cutaneous lesions that may dramatically increase the occurrence of eye infections, often limited to the ocular mucosal surface, conjunctiva, cornea, lids, lashes and adnexa. In addition to these generic symptoms there are also pathogen-specific ocular complications.

Botulism, an infection caused by *Clastridium botulinum*, causes paralysis of the extraocular muscles and eyelids as well as blurred vision.⁶ **Anthrax** can cause eyelid necrosis leading to corneal drying and without appropriate ocular treatment in turn lead to corneal scarring and ulceration with vision loss. **Smallpox**, a viral infection, affects the eyes in approximately 10 percent of cases causing conjunctival and vascularized scars and ulcers in addition to corneal perforation, intraocular infection and inflammation, optic nerve inflammation, periorbital and orbital inflammation and blindness.^{7,8} The smallpox vaccine can cause similar but less severe ocular problems as was reported to occur in U.S. military personnel receiving mandatory vaccinations. These complications were often the result of self-inoculation from rubbing the eye or scratching the skin or cross-inoculating from a close contact. Anyone receiving the vaccination should be vigilant to avoid self- and cross-contamination by avoiding scratching or touching any rashes, pustules or scabs that may result. *Francisella tularensis*, a highly infective bacterium, causes **oculoglandular tularemia**, which is characterized by eye irritation, pain, discharge, eyelid ulcers and enlarged lymph nodes. Usually it is the result of conjunctival self-inoculation handling an infected animal.⁹

Given the potential for biologic warfare, an understanding of its health consequences including those related to ocular health is vital for training and containment efforts. Education of specific signs and symptoms of exposure and early intervention remain the best means of minimizing the severity of negative health consequences after infection.

¹ Riedel, S. (2004). Biological warfare and bioterrorism: a historical review. Proceedings (Baylor University. Medical Center), 17(4), 400-406

² <http://www.un.org/disarmament/WMD/Bio/>

³ <http://www.intelligence.senate.gov/130312/clapper.pdf>

⁴ Franz, D. R., Jahrling, P. B., Friedlander, A. M., McClain, D. J., Hoover, D. L., Bryne, W. R., ... & Eitzen, E. M. (1997). Clinical recognition and management of patients exposed to biological warfare agents. *Jama*, 278(5), 399-411

⁵ Lancet, T. (2003). Laws, war, and public health. *The Lancet*, 361(9367), 1399

⁶ Franz, D. R., Jahrling, P. B., Friedlander, A. M., McClain, D. J., Hoover, D. L., Bryne, W. R., ... & Eitzen, E. M. (1997). Clinical recognition and management of patients exposed to biological warfare agents. *Jama*, 278(5), 399-411

⁷ Semba, R. D. (2003). The ocular complications of smallpox and smallpox immunization. *Archives of ophthalmology*, 121(5), 715-719

⁸ Fillmore, G. L., Ward, T. P., Bower, K. S., Dudenhoefer, E. J., Grabenstein, J. D., Berry, G. K., & Madigan Jr, W. P. (2004). Ocular complications in the Department of Defense smallpox vaccination program. *Ophthalmology*, 111(11), 2086-2093

⁹ http://publichealth.va.gov/docs/vhi/chem._bio_rad_weapons.pdf

